De-anthropocentrising Ocean Object Relations

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ABSTRACT | The ocean can be seen as a hard-to-reach place for human empathy and tangible connection for inspiring behaviour changes to reduce climate change impacts. A healthy ocean is crucial for essential human activities ranging from transport, food, oxygen, CO_2 absorption, recreation, and tourism. For a long time, designers have been engaged with designing for the ocean primarily through recreational and industrial equipment for fishing, tourism, transportation, and leisure. A new climate critical role for design is emerging which requires a strategic systems-based approach combined with more traditional design solutioning methods. We conducted a design research experiment using an AI sensor package installed on a ship to geolocate and identify objects across the Atlantic Ocean on a 6,070 nautical mile voyage between Kangerlussuaq in the Arctic Circle in Greenland and Poole in Dorset, UK. The motivation was to conduct a broad cross-sectional object identification scan using 4k cameras to capture 'everything that isn't the ocean' to begin connecting the intangible ocean for co-designing solutions. The focus of this research is to identify theories and concepts of object-network relations that go beyond anthropocentric concerns to include more diverse stakeholders and multi-species representation and communication in future design work. We examine a range of theories from Actor Network Theory, Boundary Objects, Suffixscapes and Object Oriented Ontology to compare pre- and post-theorising with applied fieldwork to draw insights around liberating conceptual models. We conclude by discussing how we can enhance inclusive representation of 'others' into climate sensitive research and design driven decision-making processes.

KEYWORDS | DE-ANTHROPOCENTRISATION, OBJECT NETWORKS, OCEAN FUTURES, DESIGN THEORY

1. Introduction

Designers often tackle ocean issues after encountering a problem via personal experience or reviewing secondary material. While this has many benefits it also risks diverting crucial effort away from the most critical areas. Issues like ocean plastics impact are serious but they are also tangible, encouraging design solutions. Even more significant challenges like a 2^0C warming of the seas or the resilience challenge posed by cascading regime shifts (tipping points) (Rocha et al, 2018; McKay et al, 2022; OECD, 2022; Dietz, Rising, Stoerk, Wagner, 2012) impact ocean systems which are some of the most sensitive to change and far more difficult to address. A new global role for design is emerging which requires a strategic systems-based approach combined with the more traditional design innovation solution methods. This opens the possibility of exploring the potential for behaviour change to support coastal communities to shift from vulnerabilities to enhanced adaptive capacity (McKinley, Burdon, Shellock, 2022) to cope with widely anticipated future coastal change. At the heart of this role shift lies a need to connect ocean science and data with communities who need to use evidence of how the ocean is changing to adapt to new practices and relations. In other words, there is a need to bridge the quantitative and qualitative data gap between evidence and action.

The New Economic Models for the Ocean (NEMO) is a long-term project awarded a UNESCO Ocean Decade (IOC,2021) implementing partnership from 2023-2030. The core concept is to support developing new economic models for the ocean recognising that sustainability and regeneration have complex human and environmental connections. We decided to conduct an initial experimental survey that would go beyond 'design issue selection' and focus instead on data gathering. Our aims were to:

- o   Develop a design research experiment that could traverse the quantitative-qualitative data gap.
- o   Open the possibility of new ocean issues and new understandings to emerge.
- o   Use data visualisation techniques to make the ocean and its objects more tangible.
- o   Support a long-term strategic prioritisation of design effort.
- o   Focus on a broad definition of objects as potentially designable outcomes.

The experiment involved a broad cross-sectional object identification scan using four 4k AI cameras and a sensor package (Fig. 1 right) mounted on the monkey island of the St Helena ship (Fig. 1 left) to capture 'everything that isn't ocean' between Kangerlussuaq in the Arctic Circle in Greenland and Poole in Dorset UK via the Azores, Gibraltar, and Sardinia in Italy. This unusual voyage was away from shipping lanes, and once the AI sensor package and cameras were installed, data and recordings were made continuously throughout with the research team swapping drives in Sardinia (further details of the technology packages, quantitative data analysis and qualitative co-design work are reported in separate forthcoming publications).

Figure 1. The St Helena showing camera survey angles, the sensor package located in the radio room and camera shrouds located port and starboard on the monkey island handrail approx. 30m above the ocean.

Our methodology involved an initial critical review of potential object-network theories followed by a comparison and an exploration of combinations of models. We then conducted a pre-and post-engagement analysis to reflect on how the theories might influence our understanding and shaping of ocean-object network relations on the transatlantic identification voyage. The influences could apply to a range of areas from participants' engagement planning and emergent methodology progression to technology selection and integration through to meta level

approaches that inform more subtle types of decision making. We also speculated how our current understanding can enhance inclusion and representation of other xeno-species (Schmeer, 2019) into climate sensitive research and decision-making processes.

2. Ocean Object Network Relations

The literature building towards a de-anthropocentrised position is too large to review here but includes notable examples from Carson's Silent Spring (1962) to Serres work on describing the parasitical tendencies of human-planet relations (1992) and the impact of world objects (2006). While there exists design literature exploring what might be broadly termed as 'de-anthropocentrisation' there remain few examples testing or comparing theories in practice beyond speculative works and even fewer that test out large-scale explorative data gathering away from land-based environments. We use the slightly awkward term de-anthropocentrisation here to deliberately indicate the desire to shift away from human-centred decision making in complex systems (climate change) as opposed to the broader interests of post-humanism which has wider concerns. Earlier work by the Authors (Hall and Wojdecka, 2021) has highlighted the need to de-anthropocentrise healthcare environments and the need to invert the position of human-centred design in the value pyramid (Hall and Wojdecka, 2021, p.5). In the context of this research a powerful need emerged to review several theories that could underpin our experiments and provide opportunity for future work aiming to reduce anthropogenic privileges. The space between de-anthropocentrising theories and the practices of design contain confusions and contentions and it is not our intention to solve these, only to illuminate where possible our experiences of them.

The aim of concentrating on objects is to consider how follow-on co-design interventions can be focussed on tangibility and how coastal communities can relate to these artifacts in terms of everyday lives, routines, and rituals, and how these objects can elicit narratives and physical, cultural, and psychological connections. One of the key challenges in this work is to develop an understanding of the relations not only between humans and objects, but also allow possibilities for other actors beyond the human sphere. These can range from objects, events, and living ecosystem to animals, plants, and ocean life. The challenge was to find a conceptual model that supports us to make decisions on tools, methods, methodologies, and analysis processes that maintain a potential for the inclusion of the 'other' at future stages of the research. We also felt the need to question traditional design anthropocentric preferences in terms of what could be considered an object and move beyond objects as products and linked service experience solutions to liberate new creative opportunities.

Serres defines an object as literally 'that which has been thrown or which one throws in front' (Serres, 2006, p3). We developed an expanded notion of objects going beyond those made by humans and nature, and used a shorthand description of things that could be perceived as 'moving against the background' to provide more co-researching narrative power allowing co-design processes to move beyond more traditional object orientated problem solving. Apart from the human tangibility of objects there also exists the potential of intra-object relations. These were important considerations to drive decision making and visualisation design in a 3-dimension geolocation visualisation platform that we could use with participants.

3. De-anthropocentrising Theory

We considered a range of object-network theories. There are no methodologies we have found that prescribe which theories should be considered or in which combination and we have therefore used a variety, some of which the researchers have experience of using in previous fieldwork and others only on a theoretical level. Some of the theories we have selected are clearly part of much larger philosophical movements while others are more discrete in scale. This is important as we recognise that the terms theory, concepts, and philosophy have varied usage across the sources we have reviewed.

A prime candidate for consideration is Actor Network Theory (ANT), a material semiotic theory originally developed by Bruno Latour (2005), Callon, Law and others to remove human-centred priorities in network relations to allow new types of power structures to emerge from elements that have traditionally been excluded or marginalised. Non-human actors can drive change and gain power in social scenarios. Actors (or actants) are anything that has the power to apply change communicated by a mediator to other actors. Power is derived from how new power (politics) emerge from the network. However, there are several contentions with ANT. The definition of what is an actor, and an intermediary (mediator) is inconsistent following research by Toenneson et al (2006) who reviewed material from seventeen ANT journals finding differences in "material," and the attribution of authorship and responsibility. The impartiality of actor networks has been questioned by Mutch (2002), and Collins and Yearley

(1992) highlighting one of the key limitations of non-human liberation governed by human networking efforts. Latour and others have resisted turning ANT into a technology driven networking effort although many examples have since been created including healthcare technology (Cresswell, Worth and Sheikh, 2010), online community participation (Rivera and Cox, 2016), and development informatics (Faik, Thompson, Walsham, 2013). Revisiting ANT Latour has claimed that it is "a powerful tool to destroy spheres and domains…Yet it is an extremely bad tool for differentiating associations" (Latour, 1996, p.380).

The issues of differentiating between actors and mediators can have significant impacts on where power relations lie but even more significantly in a design context can mean very different things can become visualised as 'objects' (actors) versus mediators and affect design issue emergence and follow on action.

Boundary objects (BO) are an extension of ANT developed by Star and Grisemer based on the study of Berkeley's Museum of vertebrate zoology collections. They set up the building blocks differentiating away from ANT with an opposite view of emergent boundary objects concentrating on conceptual variance with rich and thick descriptions. Star and Grisemer identify a series of 4 inter-related boundary objects including: repositories, ideal types, coincident boundaries, and standardised forms. The institutional value of boundary objects is further confirmed by Caccamo, Pittino and Tell (2023) who conducted a literature review of 87 sources finding that they are a multifaceted construct, integral to organisational life. The organising role can be a competitive advantage leading to organisation improvement uncovering how boundary objects are a fundamental part of the innovation process. Scoles (2018) in researching messy objects describes how boundary objects can strengthen the pursuit of ANT studies in continuing education. In studying the overlaps, Scoles recommends delimiting linear mediators and following the actors to find emergence. Boundary objects have emerged from a diverse range of contexts including contracts. Franco-Torresa, Rogers and Ugarellic, (2020) study the agency role of a city sustainability department and how it changed the urban concept of water flows. They explore water flows in city emergency events and identify some useful sub-concepts including pluralistic tolerance, selection pressure, social worlds (worldview) and objects as shared aims. The city's flood plan is identified as the boundary object and its impact on the collaboration of several agencies is reported. Closer to design research Comi and Vaara (2021) study political dynamics in knowledge work with a special focus on visual artifacts dealing with pragmatic boundaries. In the context of an architectural practice, they conclude that visual artifacts can manipulate the boundaries of organisations with political impact.

In design research Balint and Pangaro (2017) stretch the concept of boundary objects from the role of emergence in social sciences to a provocative probe in a design context. The use is inverted from a slowly emerging realisation to an object that transgresses boundaries and links to Scoles' use of the term messy objects (2018). We therefore see potential for boundary objects as either emergent opportunities in networks to unleash new creative potential via divergent issue descriptions or via the Balint Pangaro approach of creating boundary objects with the specific purpose of probing new opportunities. Limitations for our purposes emerge from the higher degree of anthropogenic focus, particularly if traditional thick and rich descriptions are used and more emphasis is placed on actors as opposed to mediators due to the focus on an emergent common. This may have the effect of offering less xeno (different in origin, non-human) opportunity in the future unless a particular focus is applied.

Suffixscapes (Appadurai, 1990) derive from the field of global cultural anthropology with an aim to identify and explore disjunctions, or unequal flows of power across a series of thematic landscapes. Conversations and communication take place across a global series of landscapes or 'scapes' including the: Ideoscape (disseminating ideas), Ethnoscape (cultural movement of people), Technoscape (how machines facilitate impact), Mediascape (presenting and shaping of information and opinion) and the Financescape (rapid economic movement of money). Disjunctions provide pivotal points of focus showing how power is leveraged over different groups both within and across suffixscapes, national borders and continental boundaries. The aim is to bring forth new voices and make cases for reducing exploitative structures and institutions. In hindsight suffixscapes can be seen in the context of decolonisation and remains an under-utilised idea in the field. Modifications to suffixscapes include Bello's Goodscapes with a focus on objects (Bello, 2010), and examples of this theory exist in practice-based design research including translocated design by the Authors (Hall, 2013; Hall, 2017) and Rassouli (2024) in the context of decolonising resource constrained innovation. Although unsurprisingly not mentioned in the literature (1990), suffixscapes focus entirely on human-centred concerns in power relations. This does not however preclude its use more widely to identify disjunctions between 'other' species, human and object relations in the context of climate issues. For example, the CETI initiative (2024) is devoting considerable resource to decoding whale speech to develop inter-species communication affording the future opportunity to bring other species into suffixscapes communications. In the case of whales, identifying disjunctions in human-ecosystem impact could prove very revealing. In Appadurai's later work we can gain significant value from the following statement that:

> "The primary problem with images of object agency, network and the device is not just that they tend to lose the soul of objects, in spite of their intentions to reanimate the object, but that they have no real grip on the deepest problem of objects, which is their capacity to generate contexts. The problem of contexts is one of the black holes of current social science, and this black hole opens new possibilities for thinking about design processes from a social and cultural point of view." (Appadurai, 2013, p.258)

The black hole highlights a major issue in the social sciences that is not dealt with in boundary objects, that objects emerge from context as human-driven interaction but tell us very little about the reverse, how objects make contexts. This is addressed in part by ANT and semiotic relationality "a network whose elements define and shape one another" (Law, 2007, p.7). The questions around objects and contexts reinforces our decision to focus on objects and how they can be significant creators of place, meaning and most importantly the capacity for difference and change.

In design terms capturing disjunctions through co-research and co-design processes could focus effort on more strategically valuable places with a thematic link to scapes highlighting design opportunities. While suffixscapes is conceptually weak in dealing directly with objects, work by Authors (Hall, 2013; Hall, 2017) and Rassouli (2024) have shown that there is no issue with object inclusion as a research focus.

Object orientated ontology (OOO pronounce triple 'O') emerged from the analytical branch of western philosophy sitting within speculative realism. It reacts against the history of human-centric ontology in philosophy and instead proposes an object orientated approach that flattens human value pyramids and creates places and spaces for emergence. It shares an affinity with some aspects of ANT and boundary objects but rejects the networking of ANT and the actor human-centred focus of boundary objects. Graham Harman (2018), Ian Bogost (2012), Levi R. Bryant and Timothy Morton (2013) amongst others have developed aspects of the philosophy which centres around a number of concepts including that all objects are created equally but some are more equal than others (Harman, 2018; Bogost, 2012), real objects and sensual objects that animate relations between real objects, and unit operations and carpentry (Bogost, 2012) referring to properties for inter-object relations and practices. Harman expends considerable effort in rejecting 'theories of everything' from physics criticising smallism (assuming that studying particles can explain all bigger structures and phenomena) causing undermining and overmining (claiming that emergence and large-scale observations are driving forces). The combined duomining integrates critical approaches that attack object centred philosophies from both below and above. Criticism of physics 'theories of everything' can be summarised as theories of everything that physics is interested in, but not everything is interested in physics. An example used is religion and spirituality which string theory (the main contender as a science theory of everything (Becker, Becker and Schwartz, 2007)) is unable to explain (Harman, 2018). Religion and spirituality account for major parts of many peoples' lives and often drive huge geopolitical events yet is discounted as a subject for the theory of everything in physics. Although OOO and string 'theories of everything' are presented as diametrical opposites they both focus on sub-object properties and how exploring these relations may ultimately deliver greater understandings between humans and their environment. Harman, Bogost and others go to great lengths in exploring the nature of objects with Harman giving a useful example of the Dutch East India Company VOC as an object (Harman, 2016). The VOC has many properties of an object, but when we come to assess its components we find the ships, employees, offices, and practices are highly dispersed around the globe and cannot be seen as a traditional object in the Liebnitzian sense. Morton describes these as hyperobjects (2013). Wilde (2020) focusses on relationship issues in OOO arguing that there cannot be a hierarchy between objects and relations. This is particularly important following the OOO argument that an object cannot be summarised as the total of its external values. Furthermore, an argument is made that an object cannot be separated from where it is, aligning with Appadurai's claim that objects make contexts and the inability of current social science theory to explain how this takes place (the black hole). In a review of post-humanist theory including OOO, ANT, non-representational theory, feminist new materialism, and transhumanism Forlani (2017) argues that in the context of design research decolonial and critical race theory show that limitations of inclusion and empowerment can continue to exist in post-colonial theory. Attention is paid to OOO's flat ontology and the refusal to prioritise special interests.

In applied design research Linley, Akmal and Colton (2020) report on a design research laboratory project developing IoT interactions. They focus on how advanced technologies such as AI and IoT challenge traditional concepts of reality and find that design research and philosophy (OOO) can develop partial answers and 'proxies for the unknowable' (Lindley, Colton, Akmal, 2018). The subject of their research provides scope for OOO to provide generative ideation and experimentation although these appear to be experiences of the researchers as opposed to participants. OOO has much to offer design research both in applicable designerly concepts such as real and sensual objects alongside practices such as carpentry. Its conceptual base in aesthetics engages well with both tangible and

theoretical design practices and can have value in helping us understand visualisation of objects and diverse relations.

We are primarily interested in the conceptual power of these theories rather than their specific practices, for example rich and thick descriptions of boundary objects or highly complex network analysis of ANT, ethnography, or OOO.

4. Pre-work analysis

Based on the theories selected and reviewed in section 3, table 1 summarises the value of each of these across the criteria of research interest, project potential and assumed limitations to develop a foundation from which to gauge value. Our methodology in this respect is highly emergent (Gaver et al, 2022) and we place value on uncertainty (Gaver, Boucher and Pennington, 2005) in a constructivist epistemological position.

Table 1. Pre-data Gathering and Fieldwork Theory Analysis

Theory	Research Interest	Project Potential	Assumed Limitations
Actor Network Theory (Latour)	Ability to trace relations and de-anthropocentrise emergence of new observations and flows.	Use visualisation applications to make actor networks between ocean and human activities and natural and human produced objects.	Linearity of relations, punctuating the network, defining mediators and intermediaries, space for multi stakeholder layered narratives?
Boundary Objects (Star & Grisemer)	Emergence of boundary objects in a hard-to-reach challenging environment with complex actor relations and diverse power relations.	Potential for descriptions of conceptual variance, delimiting design assumptions around designable or physical objects.	Sophistication and richness of network interactions at scale. Ability of design research to transgress BO criteria. Human centredness.
Object Orientated Ontology (Harman)	Landscape where human agency and visibility of objects ebbs and flows allowing new realisations with potential for ocean stakeholders to find unexpected relations.	Conceptual inspiration supporting practices and allowing space for de-anthopocentrised relations through to comparing carpentry etc. to design research practices.	Lack of applied design research and in particular OOO's relationship to network and concrete relations, actions and impacts across different human and non-humans.
Suffixscapes (Appadurai)	Layered landscapes allowing conversations on disjunctions in information flows with potential to support identifying ocean issues.	Possibility to add new novel 'Bioscape' layer to de-anthropocentrise suffixscapes and allow more direct spaces for non-human agency.	Networkability of the concept. Anthropocentric model based on human layers. Object focus for design actions?

Going beyond the conceptual value of the theories we have reviewed is an opportunity to consider combinations of theories and their geometric relationships. Table 2 captures combinations of OOO, ANT, Boundary Objects and Suffixscapes across 6 combination criteria. It explores potential relational spaces for design visualisation and conceptual richness. Note that orange highlights indicate potential issues with combinations.

Table 2. Geometric Ocean Object Network Combinations

	Theory Combinations					
	Boundary Object + Suffixscapes	Boundary Object + OOO	ANT + Suffixscapes	ANT + Boundary Objects	OOO + ANT	OOO + Suffixscapes
Geometries / **Criteria**						
1. Relationship between humans & nature via objects	Human and non-human object relations can be mapped, scope for networking?	Potential for OOO and BO to exist and connect outside of human view to nature.	Networking and scapes can combine via disjunctions.	Close bounded relationship with nature accessible.	Networking power and flat OOO allow nature links.	Through OOO clear links, scapes less so but possible.
2. Power to de-anthropocentris	BO and scapes least powerful de-anthro	OOO strong potential though some BO	Good via ANT though less when combined with	ANT good potential though less with BO	Strong with both, though conceptually	Partially with OOO however scapes less

e	combination.	limitations.	scapes.	actor focus.	different in aims.	tested.
3. Connects quantitative to qualitative transfer	No limitation to quant/qual in scapes or BO literature.	Potential though not highlighted as a possibility.	Quant can be actors and scapes both quant/qual.	ANT via mediators, BO through thick and rich descript.	Via ANT good potential OOO less obvious.	Potential but may need additional methods.
4. Inclusive with future 'others' and stakeholders	Descriptively rich though less in other mediums.	Strong via OOO flatness BO good engagement.	Strong ANT less with scapes but has potential.	ANT good and qual depth of scapes supports.	OOO and ANT stakeholder linking potential.	OOO strong and scapes depth and disjunctions.
5. Tests de-anthropocentrised theories in practice	Scapes and BO's more anthro focused in practice.	OOO good potential but BO more human centred.	ANT good potential, scapes not intended for this.	ANT good potential and BO can provide qual depth.	Strong double potential but also opposites in some intentions.	OOO flat ontology designed for this but not scapes.
6. Participatory understanding of 'hard to reach' environments	Clear spatial relationships with scapes and BO practices.	BO and OOO both point towards this capacity.	ANT and scapes both have potential to connect.	BO and ANT have potential to deliver this aim well.	OOO applied concepts and ANT networking reach.	Scapes likely lead on this capacity to understand via practices.

Previous work by the Authors (Hall, 2017) found value in combining suffixscapes and ANT to discover how design process agency acted in a translocated making process across geographically distinct socio-spatial groups (Fig.2). We decided based on the object network geometrical analysis to consider OOO and Boundary Objects as our preferred conceptual candidates while leaving opportunity for Suffixscapes and ANT to play a role. OOO and BO provide a powerful combination of deanthropocentrising power with the boundary object depth, human and potentially inclusion of 'others' into design perspectives. OOO's special and expanded focus on objects is intriguing with potential to open up new co-design possibilities.
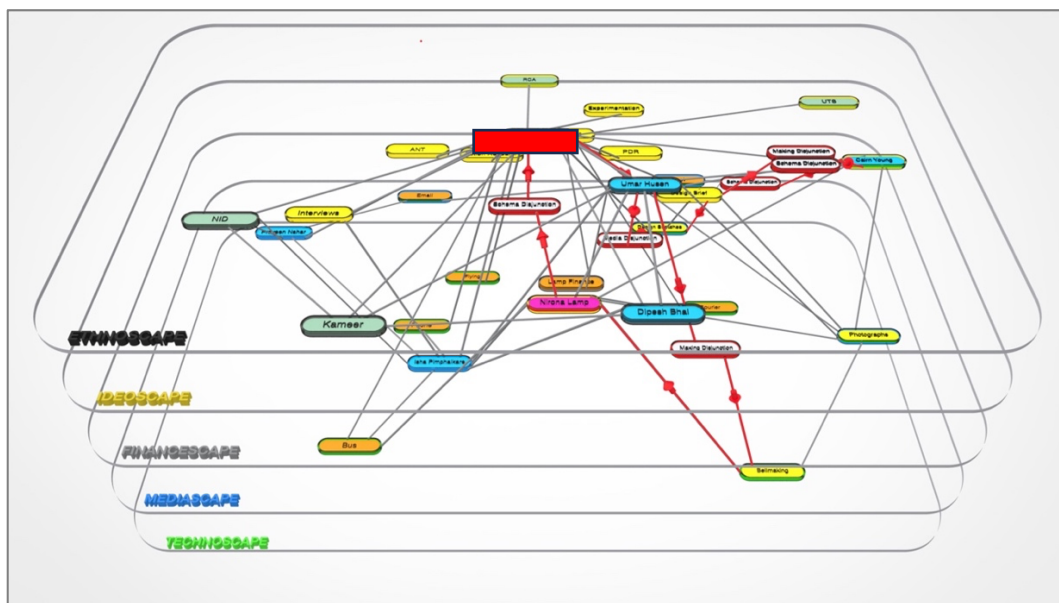

Figure 2. Combination of Suffixscapes and actor network showing role of design process in driving agency across geographies (Hall, 2017).

5. Post-engagement reflection

Data analysis via AI and a human observer using pomodoro technique (Cirillo, 2007) of the 12,140 nautical miles of 4k footage from the two wide angle cameras on port and starboard identified 3,605 objects. We decided on different spatial categorisations of above, on, and below the ocean, and human and naturally made objects.

An immediate issue was the definition of what is an object. Figure 3 shows a sample of the diversity of objects observed with some obvious examples including a seal (bottom right), dolphins (bottom centre), ships (centre and centre right), garbage (middle left), and then less certain objects. Top left shows a powerful tidal effect where the outgoing mineral rich glacial till turns the water a strong light blue-green colour as it moves quickly up the Kangerlussuaq fjord past the ship. We can also see in Figure 4 unexpectedly small objects on the left which are water and ice crystals forming on the camera lens at night and even more surprisingly on the right (3) we see the tail

end of the 500-mile-wide hurricane Larry – the largest storm in the north Atlantic for 10 years – which the ship sailed through. Our surprise with hurricane Larry was that the AI object identification (design for land-based use) was almost constantly on for several days indicated by a purple stripe on the right side of the footage (Fig. 5). It was only after thinking this through that we realised the complex sea state produced by the hurricane was interpreted by the AI as an object, one that was so big in fact that the ship sailed through the edge of it for several days. The hurricane was visible to the human observer as weather, but to our AI it was in effect a continuous object. We had not anticipated encountering any object at this scale let alone to sail through one. The glacial till tidal flow and hurricane may be conventionally recorded as effects rather than objects.

However, we wanted to ensure that all objects were treated equally as our research was experimentally emergent aiming to give future collaborators and participants equal access to all types of objects. This led us to realise that we had begun to apply OOO's more diverse arguments for what constituted an object, possibly even hyperobjects as described by Morton (2012). Hurricane Larry needed satellites, a ship, cameras, an AI sensor package, an internet connection, algorithms, visualisation software and human observers to perceive its presence. In some ways this could be compared to Harman's (2016) description of the Dutch VOC having such diverse evidence of its objectness. We also recorded other effects ranging from pools of oxygenated water, sunsets, mirages, unexplainable shadows, and various slicks. Each of these was given equal status via its description, GPS location, image icon and short MP4 clip. Combining effects into objects also addresses Manuel De Landa's criticism of OOO (Harman, 2018, p.41) not being able to address effects. Our experience also agrees with Harman's definition that "OOO means 'object' in an unusually wide sense: an object is anything that cannot be entirely reduced either to the components of which it is made or to the effects it has on other things" (Harman, 2018, p.43).
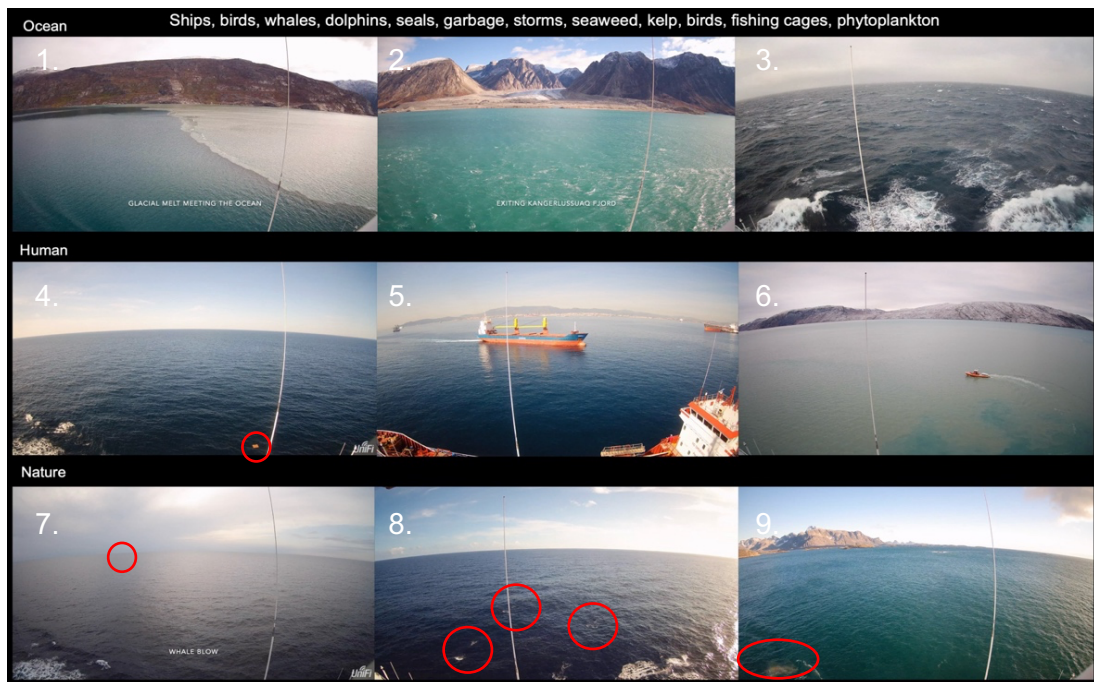

Figure 3. Diverse ocean 'objects' identified by the sensor package from ocean effects on the boundaries of an object (1,2) through to natural; megafauna (whale, dolphins, seal; 7,8,9) to human made (5,6); waste (4), ships and aeroplanes.
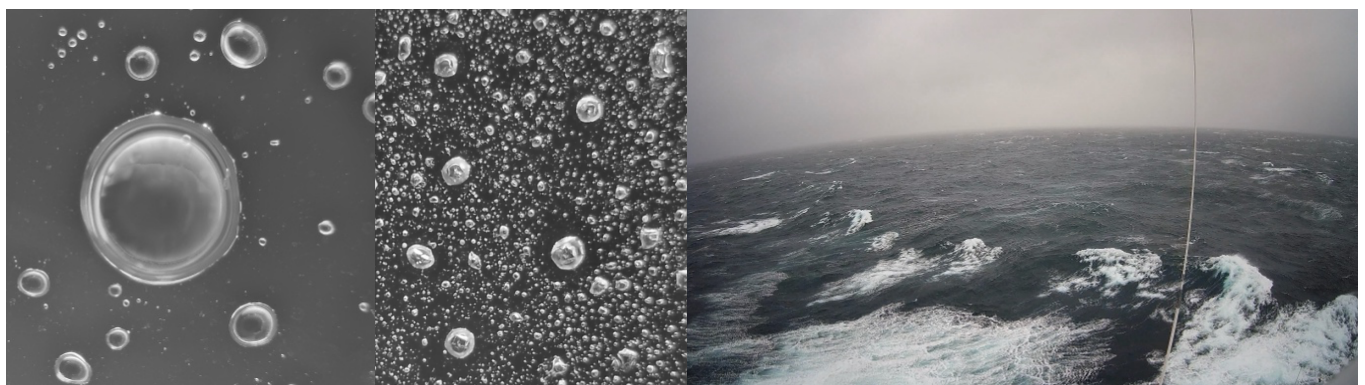

Figure 4. Objects observed vary in scale from water droplets and ice crystals 1-2mm (L) (note seascape inversion lens effect) directly on the camera lens up to the tail end of hurricane Larry around 500 miles wide that the ship sailed through (R).
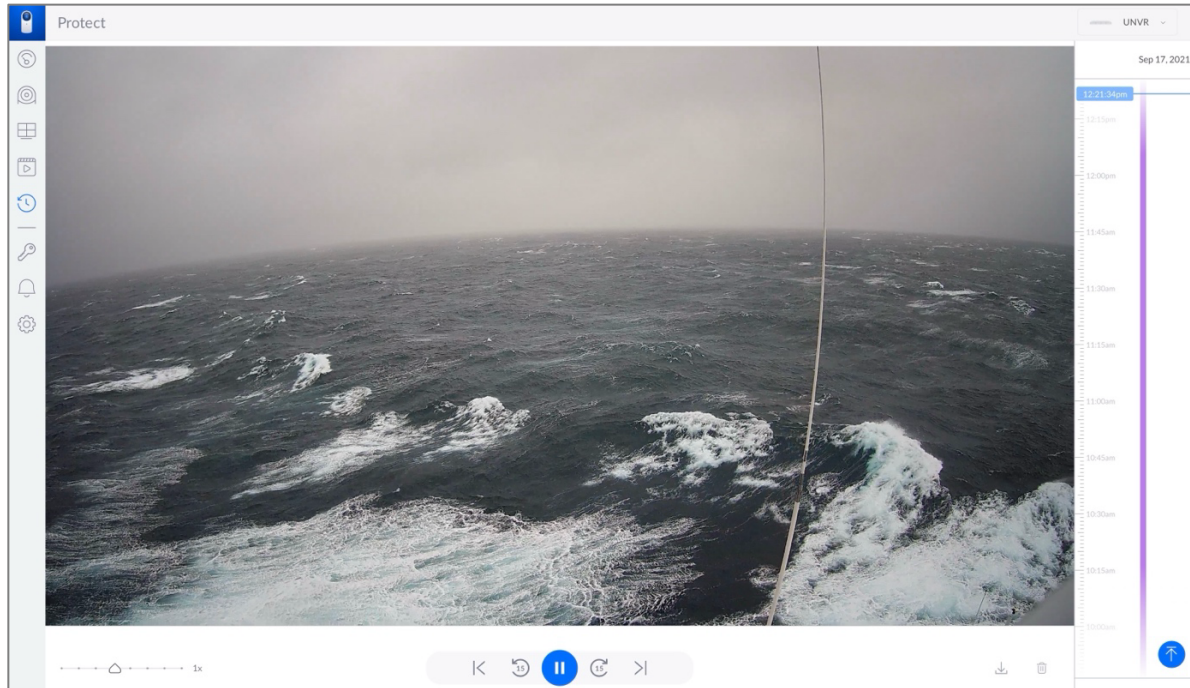
Figure 5. Evidence of Hurricane Larry as an AI 'object' (purple stripe right) on UniFi network video recorder (NVR).

Once our data had been reviewed and tested, we used Cesium Ion (2024), an open-source, three-dimensional, global GIS based geospatial visualisation platform to input our objects in their GPS positions along with icons identifying spatial separation and creator type (Fig. 6). Cesium uses a timeline which allows objects to emerge as they are recorded by our camera's allowing flythrough and time-based investigations via different use cases. A pop-up panel triggered by floating over a sighting allowed basic information on type, location, and a link to our Unifi (2024) cloud-based AI drives that provided short videos of each object. We started considering boundary objects experientially without rich and thick descriptions and found that Cesium was a good candidate in a similar way to how contracts have emerged as central connectors with agency in organisations (Franco-Torresa, Rogers and Ugarellic, 2020). Cesium delivered an ability to handle time, multiple scales from local to global, coordinate connections across several software platforms (Cesium Ion 3d geo-spatial platform (2024), Google Sheets, UniFi AI Camera (2024), Fleetmon GPS tracking (2024)) and different team members with different disciplines and skills ranging from engineering to computer science, data visualization and co-design. In terms of OOO we see Cesium as a sensual object with capacity to make new connections not only between real objects but across time, space, and diverse actors. It has scope for conceptually aestheticising these relationships providing material for considering both unit operations and carpentry (Bogost, 2012; Linley, Akmal and Colton, 2020). For future work this may allow data visualisation techniques to facilitate novel object-to-object observations not visible in real world scenarios, e.g., migration routes, salinity, ocean currents, dissimilar object densities, spatialisation etc.

Figure 6. Cesium Ion GIS trace from Kangerlussuaq in Greenland to Poole in the UK via the Azores, Gibraltar, and Sardinia. Note icons differentiating object types including events (cloud-sun) and spatial separations. RNLI flags (top right) denote a number of applied ocean design projects conducted around the UK influenced by the ocean data (to be reported separately).

We found less direct evidence for the conceptual power of suffixscapes at this stage of the research, however we anticipate the concept of disjunctions could prove powerful when mapped across institutions and geographies to identify imbalances that can be addressed through design action. Actor Network Theory was interesting in the sense that while we were aware of complex networks of actors with the power to leverage significant change and that non-human potential was significant, the resources and complexity of making transoceanic networks with an object orientated focus is conceptually and technically challenging at this stage. We feel it may be something that has potential in a future evolution of the research or can be prototyped in a more discrete way. Future steps involve exploring tangible concepts from OOO including the design potential of sensual objects applied between ocean-objects and land-based activities and considering how Cesium could enhance its role as a boundary object to open new types of communication and collaboration between human and non-human species. As the work to build on inter-species communication grows (Andreas et al, 2022; CETI, 2024) the importance of filling the gap between concept and application from human to non-humans increases.

Table 3 shows a summary of our analytical framework comprising of presence, emergence, distance, and value have been used to capture how we experienced and noted the impact of each of the theories.

Table 3. Post-fieldwork Theory Analysis

	Presence	Emergence	Distance	Value
Criteria Theory	If/where and when we saw evidence of this concept	How this concept came into being into the research	How close, integrated this became in our practices - philosophical to applied	Value gained and type (E.G. theory, data gathering, methods, analysis)
ANT	No clear evidence at this stage of the research, future potential noted.	Considered and retrospectively can be of future value.	No directly applied or considerations changing approach or decisions.	None directly at this stage of the research.
Boundary Objects	Yes, via Cesium Ion as a boundary object media connector of objects and relations.	Perceiving connections across software stakeholders, objects and hyperobjects.	We became aware of this later into the visualisation and reflection stage of the research.	Useful for understanding role of Cesium beyond data visualisation and how it has centralised ideas.
OOO	Slowly becoming stronger throughout the applied research and directly in reflection stage.	Clear value gained from a new perspective on objects improving their inclusion and actionability in design and beyond human.	This was an active conversation relating to what is/not an object from early stages of the research.	Direct value in identifying new types of objects and considering how they can be additional interests to design and co-design.
Suffixscapes	No obvious direct use, more future potential.	Considered, but yet to play a major role.	Not directly applied at this stage.	None directly at this stage of the research.

As a final speculative deviation, we return to consider Harman's critique of scientific 'theories of everything' (2018, pp. 25-38) by considering new developments in science. With the recent discovery of ambient quantum superposition (the ability of a particle to be in many places at the same time) in photosynthesis (Lloyd, 2011; Higgins et al, 2021) and Penrose and Hameroff's ground-breaking work on consciousness in Orchestrated Objective Reality (Orch OR) (Hameroff and Penrose, 2014) leading to claims that micro tubules in the brain's perceptual boundary are capable of quantum superposition (Hameroff, 2012), we speculate that from an OOO perspective an object's ability to 'see' other objects, unit operations and sensuality may not be so far from the leading neuroscience theories of consciousness and physics theories of everything. Now that we know the human brain has quantum superposition potential, we wonder if future design driven visualisation technologies can change the way that waves become particles, losing all information apart from the final position. This could indicate that we can influence vastly complex and difficult to empathise environments in a new way. OOO from philosophy, and string theory (Becker, Becker and Schwartz, 2007) from physics may end up being two sides of the same coin, rather than diametrical opposites. Data visualisation could creatively interfere in the process of Orch OR by creating new objective routes to reduce highly numerous possibilities. Could there be connections between designing experimental spatial data visualisations and the conscious triggering or realisation of quantum biological superposition embodying object orientated ontology?

6. Conclusions

With the quantitative data gathered and visualised along with some initial stakeholder engagements we have been able to reflect and speculate on the value of ANT, OOO, Boundary Objects and Suffixscapes going beyond our initial

expectations of providing conceptual stimulation for methods and tools selection. We have found strong affinities between our expanding object definition needs and OOO's real and sensual objects, carpentry, and boundary objects. We have learnt that having several theories circulating in our research has allowed us conceptual breadth, inspiration, and a broad scope for genuine emergence of conceptual value to support an emergent methodology. Many smaller decisions were supported or triggered by the theoretical breadth, and this also gave confidence in going beyond traditional design relations between people, objects, events, spaces, and scales.

Our work so far has informed our emergent methodology evolution and promises to provide more support and confidence from theory to reach out into new spaces for engaging broader consideration of who, what and others to include. The significance of this is to find direct value from concepts in OOO including real and sensual objects, unit operations, carpentry and boundary objects that directly influenced our methodology, practices and mental models concerning the research. Furthermore, we have been able to begin grounding several concepts from OOO and boundary objects directly into practice-based design research.

The speculative convergence of OOO in philosophy and quantum physics superpositions in nature is significant. We do not make a claim to connect it here, only to note there are enhanced thoughtful possibilities and converging properties worth exploring through immersive design visualisations. We may come to realise that when we say that we have a strong affinity with the ocean, it may be more than emotional.

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